WEST Search History

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DATE: Friday, April 02, 2004

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		DB=USPT; PLUR=YES; OP=ADJ	
☐	L75	performance and quadratic and node and qos and max$	16
☐	L74	L72 and qos and link$ and bandwidth	2
☐	L73	L72 and qos and node and bandwidth	2
☐	L72	performance same quadratic	462
☐	L71	performance same qos same quadratic	0
☐	L70	node$ and network and rout$ and L69	3
☐	L69	concav$ same resource$	36
☐	L68	L65 and L67	1
☐	L67	L64 and L34	398
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☐	L65	performance same (quad$ or concav$) same resource	16
☐	L64	performance same (quad$ or concav$)	7124
☐	L63	qos or quality of service	3376
☐	L62	L41 and L60	0
☐	L61	L41 and L60	0
☐	L60	709/2$$.ccls. and L59	91
☐	L59	370/2$$.ccls. and L34	808
☐	L58	370/2$$.ccls. and L55	32
☐	L57	L34 and L37 and L55	0
☐	L56	L34 and L38 and L55	33
☐	L55	inquir$ same resource	610
☐	L54	L52 and L41	0
☐	L53	L52 and concave	0
☐	L52	L38 and L51	3
☐	L51	L36 and L50	6
☐	L50	L47 and network	10
☐	L49	switch and L48	5
☐	L48	L47 and resource$	5
☐	L47	(block$ same island) and hierarchy	20
☐	L46	concave adj4 resource$	0
☐	L45	concave adj2 resource$	0

☐	L44	concave adj2 resource	0
☐	L43	L35 and L41	3
☐	L42	L34 and L41	19
☐	L41	(group$ same node$ same subset) and rout$ and communications network	77
☐	L40	L39	1892
☐	L39	(group$ same node$) and rout$ and communications network	1892
☐	L38	node$ and rout$ and communications network	9593
☐	L37	L36 same L35	140
☐	L36	(manag$ or control$) same switch	376583
☐	L35	(block$ adj3 ((island) or group))	21730
☐	L34	(block$ same ((island) or group))	93102
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☐	L28	L5 and L8 and L26	0
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☐	L26	inquir$ same resource	610
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☐	L8	L7 same L6	140

☐	L7	(manag$ or control$) same switch	376583
☐	L6	(block$ adj3 ((island) or group))	21730
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END OF SEARCH HISTORY

Refine Search

Search Results -

Term	Documents
(31 AND 12).USPT.	0
(L12 AND L31).USPT.	0

Database:
US Pre-Grant Publication Full-Text Database
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JPO Abstracts Database
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Refine Search

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Search History

DATE: Friday, April 02, 2004 Printable Copy Create Case

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L26	inquir$ same resource	610	L26
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L22	L7 and L21	6	L22
L21	L18 and network	10	L21
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L14	L6 and L12	3	L14
L13	L5 and L12	19	L13
L12	(group$ same node$ same subset) and rout$ and communications network	77	L12
L11	L10	1892	L11
L10	(group$ same node$) and rout$ and communications network	1892	L10
L9	node$ and rout$ and communications network	9593	L9
L8	L7 same L6	140	L8
L7	(manag$ or control$) same switch	376583	L7
L6	(block$ adj3 ((island) or group))	21730	L6
L5	(block$ same ((island) or group))	93102	L5
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L2	new and L1	1	L2
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END OF SEARCH HISTORY

Case List for folder "Cases"

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09402633	03-25-2004	☐
094026331	04-01-2004	☐
09491474	03-15-2004	☐
09520029	03-16-2004	☐
09546726	03-17-2004	☐
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09618998	03-17-2004	☐
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09661578	03-31-2004	☐
09662681	03-17-2004	☐
09664971	03-14-2004	☐
09879780	03-22-2004	☐

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Case Operation

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L44: Entry 1 of 1 File: USPT Feb 16, 1999

DOCUMENT-IDENTIFIER: US 5872918 A

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TITLE: System and method for optimal virtual path capacity dimensioning with broadband traffic

Abstract Text (1):
A general dimensioning method and system for allocating limited transmission resources to various virtual paths defined on top of a physical network. A two-level hierarchical structure is defined with a layer of one or more virtual paths on top of a layer of physical network elements. Traffic demand is specified for each virtual path and the Entropy Rate Function is used as a blocking measure. The loads on the various links are balanced by equalizing blocking probabilities and the optimal allocation of network physical resources is determined.

Brief Summary Text (7):
This invention relates to a system and method for the efficient dimensioning of a telecommunications network, and more particularly, to a technique for dimensioning defined virtual paths on a constrained physical network using the Entropy Rate Function as a blocking measure.

Brief Summary Text (16):
Many existing dimensioning techniques are excluded by the requirement that the dimensioning technique be capable of modeling a general traffic distribution. Most commonly used dimensioning methods are not capable of handling general traffic models because of limitations arising from the use of the Erlang blocking measure. The method and system of the present invention overcomes these disadvantages.

Brief Summary Text (19):
Given a physical network comprising a plurality of physical links, where each physical link has a prespecified transmission capacity, the system and the method of the present invention illustrates a dimensioning technique that supports a general traffic model. The dimensioning task is treated as a load balancing problem over the various physical links. The optimal solution to the virtual path dimensioning problem corresponds to that choice of allocated capacities over the various virtual paths wherein the blocking on each of the virtual paths is made as uniform as possible over the various links.

Brief Summary Text (20):
In one aspect, the present invention includes a method for efficiently dimensioning a telecommunications network having a plurality of physical links that interconnect a plurality of exchanges or nodes. A plurality of physical links are related to one or more virtual paths. Each of the virtual paths provide an individually switchable connection between a pair of exchanges or nodes in the telecommunications network. Offered traffic is specified for each of the virtual paths and a transmission capacity constraint is set for each physical link of the telecommunications network. The relationship between offered traffic and other computational parameters is modeled on the telecommunications network using an entropy-blocking measure and capacities are allocated to the plurality of virtual paths subject to

the transmission capacity constraints for the various physical links such that the blocking probabilities on the various virtual paths are made as uniform as possible within a preselected error bound.

Drawing Description Text (3):
FIG. 1 is a block diagram of an illustrative telecommunications network within which virtual path dimensioning may be effected;

Drawing Description Text (4):
FIG. 2 is a block diagram illustrating exemplary ATM cell structure;

Drawing Description Text (5):
FIG. 3 is a block diagram illustrating a number of interconnected virtual paths and virtual channels within an ATM network;

Drawing Description Text (6):
FIG. 4 is a block diagram illustrating the cross-connection and switching of virtual paths and virtual channels within an ATM network;

Detailed Description Text (16):
Referring to FIG. 3, there is shown a block diagram illustrating the switching and cross-connection of virtual channels and virtual paths within an ATM link. From the viewpoint of a switch designer, "VP switching" refers to the switching of an ATM cell using only the upper part of the identifier field, that is, the shorter field (VPI). In contrast, in "VP/VC switching" the entire identified field is used (both VPI and VCI). A VP/VC path consist of a plurality of interconnected VP/VC lengths. Switching and cross-connection can be performed at either the VP or the VC level. The virtual path identifier (VPI) and the virtual channel identifier (VCI) define a two-tier handling and routing structure within the ATM circuitry. From the network architectural standpoint, a virtual path (VP) is a bundle of individual connections, a type of "highway" in the route map of an ATM network. One important task in network management is to allocate the right amount of transmission capacity to each such highway (i.e., a virtual path) in order to optimize network performance. This optimization task is the objective of bandwidth management or virtual path dimensioning techniques and is the subject matter of one aspect of the present invention as further discussed below.

Detailed Description Text (33):
A useful model in dimensioning a telecommunications network is to treat the dimensioning problem as involving a two-layered structure consisting of a first physical network layer, with discrete topology and specified link capacities and a second virtual path layer with virtual paths and their particular routings. A traffic demand is offered to the virtual paths in this model. In dealing only with the task of dimensioning network capacity, the virtual paths are, ipso facto, already routed. Each virtual path may travel through numerous physical links but will emulate a highway comprising only a single path. Each virtual path will have one characteristic blocking value and one characteristic allocated capacity value with only as many variables in the model as there are virtual paths.

Detailed Description Text (44):
The call request process to a given route r can be any stationary process for which we know the fictitious occupancy distribution if the process were to be provided with a resource having infinite capacity that accepted all calls and avoided all blockage. X.sub.r denotes the occupancy level of this fictitious infinite capacity resource, and is commonly referred to in the art as "offered traffic".

Detailed Description Text (48):
The virtual path dimensioning task is viewed in the present invention as a load balancing problem in which the "load" is the value of an appropriate chosen blocking measure and where the optimal solution corresponds to that choice of

allocated VP capacities wherein the blocking on each of the virtual paths is distributed in as uniform a manner as possible. One way to make the blocking distribution uniform is to measure the divergence in the values of the blocking on the various virtual paths and then to minimize this divergence. This approach can be implemented using any standard minimization algorithm, for example, the well-known simulated annealing technique.

Detailed Description Text (49):
A related approach would be to first identify the virtual path having the highest blocking value and then to minimize the blocking for this virtual path by reallocating capacity from other VPs until the virtual path is no longer the VP with the highest blocking. This formulation corresponds to a min-max optimization problem and can be analytically formulated as described below.

Detailed Description Text (50):
If we denote the blocking on the i.sup.th virtual path as B (VP.sub.i), then the VP that has the largest blocking is max(B (VP.sub.i)) where the maximum is taken over all the VPs. The maximum of a blocking measure over the set of virtual paths defines the objective function (also known as the cost function) for the VP dimensioning problem. The goal of the optimization procedure therefore, is to find the minimum of the objective function, which corresponds to:

Detailed Description Text (52):
Since this technique involves pushing down the highest blocking value among all the VPs considered, an algorithm using this technique to solve an optimization problem is called an "Push Down" algorithm. This algorithm follows from the fact that the uniform blocking distribution corresponds to the best solution of the unconstrained VP dimensioning problem. Accordingly, the best solution is to allocate capacities to each VP such that the blocking on each of the VPs is made equal within an error bound. However, such a solution is not always realizable because of the capacity constraints of the various physical links. The limited capacity of a physical link needs to be shared amongst all VPs traversing that physical link.

Detailed Description Text (53):
FIG. 9 shows the various steps in one illustrative embodiment of a Push Down Algorithm for dimensioning virtual paths defined on a physical network. The dimensioning process starts at 902 with the definition of the connection topology of the various VPs. The various VPs are also assembled into a VP Dimensioning Set. The VPs are then grouped at 903 in order of the physical links that they each traverse. Initial allocations of transmission capacity are then made to each VP at 904. At 905, a target figure for reduction in blocking is chosen. To set a target, one needs to first select a blocking measure. In one preferred embodiment of the present invention, the Entropy Rate Function, as detailed in the sections following, is used as a blocking measure. The target value is used to set termination conditions for the dimensioning algorithm.

Detailed Description Text (54):
The blocking on each of the VPs is determined at 906 over each of the physical links. If the various VPs traversing a single physical link do not face the same or similar levels of blocking, then the capacities currently allocated to each of the VPs are revised at 907 so as to equalize the blocking values for the VPs within an error bound. Capacity can be added to VPs by the allocation of unallocated physical capacity or by reallocation of already allocated capacity from a less productive VP to a more productive VP. This capacity readjustment is performed without violating the capacity constraints of any of the physical links.

Detailed Description Text (55):
This process results in the identification at 908 of one or more physical links as being the bottle-necks in this optimization procedure. A physical link on which the VP blockage is the highest and whose blockage is not reducible by capacity

reallocation is referred to as a critical link. Each critical link determines the lowest blocking that can be achieved on VPs traversing that physical link. One of the principal tasks of the Push Down algorithm is to identify, at each stage of the optimization procedure, the set of critical links for a given set of virtual paths.

Detailed Description Text (56):
Once a critical link is identified at 908, physical capacities can be reallocated between the various virtual paths traversing this critical link in such a way as to equalize the blocking values for each of the virtual paths. It should be noted that when a physical link is found to be a critical link, ipso facto, it has no unallocated capacity. Consequently, only reallocation of capacity between VPs passing though a critical link is possible after the algorithm reaches this stage of the dimensioning procedure.

Detailed Description Text (58):
The dimensioning problem thus reduces to the optimization problem of minimizing the highest blocking probability for the remaining set of VPs. This permits the use of a recursive re-entrant algorithm to implement this procedure.

Detailed Description Text (59):
The blocking values from the previous step are now used as the initial values in the remaining dimensioning problem. This optimization procedure is recursively repeated at 911 until all the capacities of each of the physical links have been allocated. In summary, this greedy-type algorithm starts with dimensioning the complete set of all VPs and terminates at 912 when the set of virtual paths remaining to be dimensioned becomes a null set.

Detailed Description Text (61):
The problem of analytically identifying the critical link in a given set of VPs, has proven to be a difficult task. There are no known techniques for determining the critical link directly from the offered traffic and the physical link capacity constraints. Hence the push down algorithm employs an iterative approach to identify critical links. The algorithm is initialized for all VPs by using a uniform large blocking value for all the VPs. The initial blocking value that is selected has to be large enough so that the sum of the initially allocated values of the VP capacities do not exceed the available physical capacities of the various physical links.

Detailed Description Text (62):
By the slow and uniform reduction in the degree of blocking on the set of all the virtual paths remaining in the optimization procedure, the critical link is identified at each level as being that link which first violates the physical capacity constraints of a traversed physical link.

Detailed Description Text (63):
Dimensioning Using an Entropy Blocking Measure

Detailed Description Text (64):
The speed and efficiency of the above procedure for identifying the critical link at each stage of the dimensioning process is critically dependent upon the complexity of the blocking measure used in the modeling. Traditionally, the Erlang blocking measure (also known as the time congestion blocking formula) has been used to determine the optimal allocation of VP capacities in a network.

Detailed Description Text (65):
The present technique incorporating the use of the Entropy Rate Function as a blocking measure yields superior results to those obtainable by use of the Erlang blocking measure. The use of the Entropy Rate Function permits the modeling of arbitrary traffic distributions, and in most cases this computation can be done

much faster compared to computations based upon other blocking measures. It has also been found that the iterative search for the critical link can be substantially improved, a result principally following from the fact that the Entropy Rate Function is a convex function. Prior to a description of a dimensioning algorithm using the Entropy Rate Function, it would be useful to explore the characteristics of the Entropy Rate Function.

Detailed Description Text (66):
The Entropy Rate Function as a Blocking Measure

Detailed Description Text (67):
As noted earlier, the choice of the blocking measure is critical to the Push Down algorithm. A general expression for the blocking measure based on the Entropy Rate Function will be derived next and applied to an exemplary situation where the offered traffic is alternately modeled by single-class and by multi-class Poissonian distributions.

Detailed Description Text (68):
The Entropy Rate Function is known in the art, and has been used to model congestion at the physical link level, see, e.g., J. Y. Hui, A Congestion Measure for Call Admission and Bandwidth Assignment for Multi-Layer Traffic, International Journal of Digital & Analog Cabled Systems (1990), but has not hitherto been used as a blocking measure in solving either the dimensioning or the planning problem at either the virtual path level or at the network level. Additionally, the Entropy Rate Function has been used to define the concept of "effective capacity" of a physical link. It is important to note that the dimensioning technique using the Entropy Rate Function detailed herein is not limited to offered traffic that follows a Poisson distribution and that the system and method works equally well with any type of offered traffic distribution, including that determined by measurements.

Detailed Description Text (69):
Saturation blocking probability can be defined as the probability that the traffic demand exceeds a specified value of transmission capacity. The saturation probability is also called the "tail probability", because it denotes the probability mass of the tail of the offered traffic distribution. A well known approximation to this tail probability, namely Chernoff's Bound, is derived below.

Detailed Description Text (99):
The interpretation of the Entropy Rate Function as a blocking measure, works well if the average offered traffic on each physical link is lower than the corresponding available physical capacity on that link, i.e., if E (X.sub.k).ltoreq.C.sup.k.sub.phys. However, this condition may be violated in some realistic overload situations. Consider the following example based on homogeneous Poisson traffic and time-congestion blocking measure (i.e., the Erlang blocking formula).

Detailed Description Text (100):
TABLE 2 lists three values of allocated capacities and corresponding traffic demands that were calculated for a fixed blocking value of 0.03. Note that in the last case, the offered traffic is larger than the allocated capacity, even though the blocking is relatively low.

Detailed Description Text (101):
This example shows that the entropy blocking measure needs to be extended to cover the overload situation when the condition E(X.sub.k).ltoreq.C.sub.phys is violated. Mathematically, such an extension can be accomplished easily. As shown previously, the Entropy Rate Function is a convex function having a minimum value of zero at E (X.sub.k). The left branch of the Entropy Rate Function defines the overload region (see FIGS. 10 and 11). In this region, an increase in the Entropy Rate Function

corresponds to a decrease in the allocated capacity and to negative values of the control parameters. By changing the sign of the control parameter, Push Down algorithm based on the Entropy Rate Function can be easily extended to cover the overload region. Such an extension requires only a minor modification of the original dimensioning algorithm.

Detailed Description Text (107):
As discussed earlier, the objective of the optimization in the right side region of the entropy curve was to increase the capacity allocated to the VP having the highest blocking (i.e., the VP with the least entropy blocking measure). This corresponds to a maxi min formulation of the optimization problem. It should be noted that the optimization objective for the left side region can be transformed to an optimization problem for the right side region by replacing the term "utilization" by the term "blocking" and the term "largest consumer of resources" by the term "VP with the largest blocking" in the earlier formulated optimization objective for the left side region.

Detailed Description Text (110):
We can apply the above-detailed characteristics of the Entropy Rate Function to solve the VP dimensioning problem efficiently. As explained earlier, the VP dimensioning problem aims at allocating limited physical network resources amongst a plurality of predefined VPs given an offered traffic distribution. One embodiment of a VP dimensioning algorithm that uses the Entropy Rate Function as a blocking measure is shown in FIG. 12.

Detailed Description Text (112):
It should be noted that steps 1202 to 1204 may be performed in any order depending on implementation considerations. Further, I.sub.MAX is specified at 1204 only if there is a realistic likelihood of the offered traffic distribution having a truncated right tail i.e., only if P(X>C) is zero for values of X that are greater than some finite value, C.sub.MAX. If an offered traffic distribution has a truncated right tail, then it is theoretically possible to size network resources to achieve zero blocking. However, such situations are rare in practice.

Detailed Description Text (113):
Other initialization steps include the selection of large and equal blocking values for each of the Virtual Paths at 1205. As explained elsewhere, there is an inverse relationship between the values of the Entropy Rate Function and the corresponding blocking on a VP. Consequently, large blocking values correspond to small values of the Entropy Rate Function. Using the relations developed earlier, initial capacity allocations for the various VPs are also computed at 1205.

Other Reference Publication (5):
J. P. Labourdette & G. W. Hart, Blocking Probabilities in Multitraffic Loss Systems: Insensitivity Asymptotic Behavior, and Approximations, IEEE Transactions on Communications, vol. 40, No. 8, pp. 1355-1365 (Aug. 1992).

CLAIMS:

1. A computer implemented method of dimensioning virtual paths defined on a telecommunications network carrying general traffic, said network having a plurality of interconnected links whose transmission capacities are limited, said dimensioning method comprising the steps of:

choosing an appropriate entropy rate function to model the load on each virtual path of said telecommunications network wherein said entropy rate function is determined by idealizing the characteristics of offered traffic on a telecommunications network;

selecting a solution algorithm using the entropy rate function as a blocking

measure that is operative to solve a load balancing problem for said general traffic; and

performing computations on a computing system using said load balancing algorithm incorporating said entropy rate function to produce a load distribution on said virtual paths that is as uniform as possible wherein the entropy blocking measure used to model the offered traffic is the Entropy Rate Function, 1.sub.x (C), said Entropy Rate Function being calculable as the approximation of the negative logarithm of the probability that an arbitrarily distributed random variable, X, is greater than or equal to a preselected value, C, and said Entropy Rate Function additionally being a convex function obtaining its minimum value of zero at the mean of the distribution.

2. A computer implemented method of dimensioning virtual paths defined on a telecommunications network carrying general traffic, said network having a plurality of interconnected links whose transmission capacities are limited, said dimensioning method comprising the steps of:

choosing an appropriate entropy rate function to model the load on each virtual path of said telecommunications network;

selecting a solution algorithm using the entropy rate function wherein said algorithm using the entropy rate function as a blocking measure that is operative to solve a load balancing problem for said general traffic is a push down algorithm, as a blocking measure that is operative to solve a load balancing problem for said general traffic; and

performing computations on a computing system using said load balancing algorithm incorporating said entropy rate function to produce a load distribution on said virtual paths that is as uniform as possible, and wherein said push down algorithm further comprises the following steps:

assembling the virtual paths to be dimensioned into a dimensioning set;

calculating the blocking on each virtual path at every network link traversed by said virtual path using said chosen entropy rate function;

identifying the virtual path having the largest blocking on each network link; and

allocating additional capacity to the identified virtual path without violating the network resource constraints till it no longer has the highest blocking.

3. A computer implemented method of dimensioning virtual paths defined on a telecommunications network carrying general traffic, said network having a plurality of interconnected links whose transmission capacities are limited, said dimensioning method comprising the steps of:

choosing an appropriate entropy rate function to model the load on each virtual path of said telecommunications network;

selecting a solution algorithm using the entropy rate function wherein said algorithm using the entropy rate function as a blocking measure that is operative to solve a load balancing problem for said general traffic is a push down algorithm as a blocking measure that is operative to solve a load balancing problem for said general traffic; and

performing computations on a computing system using said load balancing algorithm incorporating said entropy rate function to produce a load distribution on said virtual paths that is as uniform as possible; and wherein said push down algorithm further comprises the following iterative steps which are repeated until said

dimensioning set becomes a null set;

grouping all virtual paths into a dimensioning set;

specifying the transmission capacity of each physical link;

choosing a relatively large initial blocking value for each virtual path;

selecting an error bound to evaluate the convergence of a critical link identifying algorithm;

determining the blocking value for each virtual path using an entropy blocking measure;

iteratively identifying the virtual path having the largest blocking value as long as the physical link has available capacity;

reducing the blocking of the virtual path having the largest blocking value by reallocating transmission capacities amongst said virtual paths as long as no physical link reaches full utilization and the blocking reductions of the maximally-obstructed virtual path is greater than a preselected error bound,

identifying physical links lacking allocable capacity as critical links;

eliminating all virtual paths spanning critical links from the dimensioning set; and

iteratively readjusting the transmission capacities of the remaining physical links to reflect the capacities allocated to virtual paths most recently eliminated from the dimensioning set.

4. A method for dimensioning virtual paths defined on a telecommunications network having a plurality of physical links interconnecting a plurality of nodes, said method comprising the steps of:

mapping said plurality of physical links into one or more virtual paths, each of said virtual paths providing an individually switchable connection between a pair of nodes in the telecommunications network;

specifying the transmission capacity of each physical link;

assembling a selected plurality of said virtual paths into a dimensioning set;

allocating initial values of transmission capacity to each virtual path in said dimensioning set using the entropy rate function as a blocking measure, each of said initial values being equal and chosen so that the blocking is large;

recursively identifying as critical links those physical links whose capacities are fully allocated amongst the virtual paths traversing them, by the following sub steps:

incrementing the entropy rate function estimate by a fixed value;

recalculating the shift parameter for each virtual path in said dimensioning set;

recalculating the capacity to be allocated to each virtual path using said incremented entropy rate function estimate and said recalculated shift parameter; and

summing the capacities allocated to all of said virtual paths for each physical

link to obtain the total allocated capacity on each physical link; and

comparing said total allocated capacity of each physical link to its specified capacity to determine if the unallocated capacity said physical link is substantially zero;

outputting the currently allocated capacities on each of the virtual paths traversing a physical link identified as a critical link;

removing all virtual paths traversing each critical physical link from said dimensioning set; and

redefining the specified physical capacities of said physical links to compensate for the capacities allocated to said removed virtual paths.

5. A computer implemented system for dimensioning virtual paths defined on a telecommunications network carrying general traffic, said network having a plurality of interconnected links whose transmission capacities are limited, said dimensioning method comprising:

means for choosing an appropriate entropy rate function to model the load on each virtual path of said telecommunications network;

means for selecting a solution algorithm using the entropy rate function, and wherein said entropy rate function is determined by idealizing the characteristics of offered traffic on a telecommunications network as a blocking measure that is operative to solve a load balancing problem for said general traffic; and

means for performing computations on a computing system using said load balancing algorithm incorporating said entropy rate function to produce a load distribution on said virtual paths that is as uniform as possible; and

wherein the entropy blocking measure used to model the offered traffic is the Entropy Rate Function, I.sub.x (C), said Entropy Rate Function being calculable as the approximation of the negative logarithm of the probability that an arbitrarily distributed random variable, X, is greater than or equal to a preselected value, C, and said Entropy Rate Function additionally being a convex function obtaining its minimum value of zero at the mean of the distribution.

6. A computer implemented system for dimensioning virtual paths defined on a telecommunications network carrying general traffic, said network having a plurality of interconnected links whose transmission capacities are limited, said dimensioning method comprising:

means for choosing an appropriate entropy rate function to model the load on each virtual path of said telecommunications network;

means for selecting a solution algorithm using the entropy rate function as a blocking measure that is operative to solve a load balancing problem for said general traffic; and

means for performing computations on a computing system using said load balancing algorithm incorporating said entropy rate function to produce a load distribution on said virtual paths that is as uniform as possible and wherein said algorithm using the entropy rate function as a blocking measure that is operative to solve a load balancing problem for said general traffic is a push down algorithm and

means for assembling the virtual paths to be dimensioned into a dimensioning set;

means for calculating the blocking on each virtual path at every network link

traversed by said virtual path using said chosen entropy rate function;

means for identifying the virtual path having the largest blocking on each network link; and

means for allocating additional capacity to the identified virtual path without violating the network resource constraints till it no longer has the highest blocking.

7. A computer implemented system for dimensioning virtual paths defined on a telecommunications network carrying general traffic, said network having a plurality of interconnected links whose transmission capacities are limited, said dimensioning method comprising:

means for choosing an appropriate entropy rate function to model the load on each virtual path of said telecommunications network,

means for selecting a solution algorithm using the entropy rate function as a blocking measure that is operative to solve a load balancing problem for said general traffic;

means for performing computations on a computing system using said load balancing algorithm incorporating said entropy rate function to produce a load distribution on said virtual paths that is as uniform as possible and wherein said algorithm using the entropy rate function as a blocking measure that is operative to solve a load balancing problem for said general traffic is a push down algorithm; and

means for grouping all virtual paths into a dimensioning set;

means for specifying the transmission capacity of each physical link;

means for choosing a relatively large initial blocking value for each virtual path;

means for selecting an error bound to evaluate the convergence of a critical link identifying algorithm,

means for determining the blocking value for each virtual path using an entropy blocking measure;

means for iteratively identifying the virtual path having the largest blocking value as long as the physical link has available capacity;

means for reducing the blocking of the virtual path having the largest blocking value by reallocating transmission capacities amongst said virtual paths as long as no physical link reaches full utilization and the blocking reductions of the maximally-obstructed virtual path is greater than a preselected error bound;

means for identifying physical links lacking allocable capacity as critical links;

means for eliminating all virtual paths spanning critical links from the dimensioning set; and

means for iteratively readjusting the transmission capacities of the remaining physical links to reflect the capacities allocated to virtual paths most recently eliminated from the dimensioning set.

8. A system for dimensioning a constrained telecommunications network having a plurality of physical links interconnecting a plurality of nodes, said system comprising:

means for mapping said plurality of physical links into one or more virtual paths, each of said virtual paths providing an individually switchable connection between a pair of nodes of the telecommunications network;

means for grouping a selected plurality of said virtual paths into a dimensioning set;

means for allocating initial transmission capacity to each virtual path such that the blocking is initially large;

means for selecting a subsequent value for blocking that is lower than the current value;

means for calculating the blocking on each of said virtual paths traversing a single physical link;

means for allocating the available transmission capacity amongst virtual paths traversing a single physical link in response to variations in the blocking amongst different virtual paths until a physical link is identified as having no unallocated capacity;

means for removing all virtual paths traversing said identified physical link from said dimensioning set;

means for reducing the transmission capacity allocated to each of the physical links by an amount previously allocated to said removed virtual paths; and

means for iteratively repeating said calculating, allocating, removing and reducing steps until no virtual paths are left in the dimensioning set.

9. A system for dimensioning virtual paths defined on a telecommunications network having a plurality of physical links interconnecting a plurality of nodes, said system comprising:

means for mapping said plurality of physical links into one or more virtual paths, each of said virtual paths providing an individually switchable connection between a pair of nodes in the telecommunications network;

means for specifying the transmission capacity of each physical link;

means for assembling a selected plurality of said virtual paths into a dimensioning set;

means for allocating initial values of transmission capacity to each virtual path in said dimensioning set using the entropy rate function as a blocking measure, each of said initial values being equal and chosen so that the blocking is large;

means for recursively identifying as critical links those physical links whose capacities are fully allocated amongst the virtual paths traversing them, said identifying means comprising:

means for incrementing the entropy rate function estimate by a fixed value;

means for recalculating the shift parameter for each virtual path in said dimensioning set;

means for recalculating the capacity to be allocated to each virtual path using said incremented entropy rate function estimate and said recalculated shift parameter; and

means for summing the capacities allocated to all of said virtual paths for each physical link to obtain the total allocated capacity on each physical link; and

means for comparing said total allocated capacity of each physical link to its specified capacity to determine if the unallocated capacity said physical link is substantially zero;

means for outputting the currently allocated capacities on each of the virtual paths traversing a physical link identified as a critical link;

means for removing all virtual paths traversing each critical physical link from said dimensioning set; and

means for redefining the specified physical capacities of said physical links to compensate for the capacities allocated to said removed virtual paths.

10. A computer implemented method of dimensioning virtual paths defined on a telecommunications network carrying general traffic, said network having a plurality of interconnected links whose transmission capacities are limited, said dimensioning method comprising the steps of:

choosing an appropriate entropy rate function to model the load on each virtual path of said telecommunications network;

selecting a solution algorithm using the entropy rate function wherein said algorithm using the entropy rate function as a blocking measure that is operative to solve a load balancing problem for said general traffic is a push down algorithm, wherein said push down algorithm further comprises:

the following iterative steps which are repeated until said dimensioning set becomes a null set;

grouping all virtual paths into a dimensioning set;

specifying the transmission capacity of each physical link;

choosing a relatively large initial blocking value for each virtual path;

selecting an error bound to evaluate the convergence of a critical link identifying algorithm;

determining the blocking value for each virtual path using an entropy blocking measure;

iteratively identifying the virtual path having the largest blocking value as long as the physical link has available capacity;

reducing the blocking of the virtual path having the largest blocking value by reallocating transmission capacities amongst said virtual paths as long as no physical link reaches full utilization and the blocking reductions of the maximally-obstructed virtual path is greater than a preselected error bound;

identifying physical links lacking allocable capacity as critical links;

eliminating all virtual paths spanning critical links from the dimensioning set; and

iteratively readjusting the transmission capacities of the remaining physical links to reflect the capacities allocated to virtual paths most recently eliminated from

the dimensioning set;

as a blocking measure that is operative to solve a load balancing problem for said general traffic; and

performing computations on a computing system using said load balancing algorithm incorporating said entropy rate function to produce a load distribution on said virtual paths that is as uniform as possible; and

wherein the step of reducing the blocking of the virtual path having the largest blocking value in the push down algorithm is performed using a successive approximation technique.

11. A computer implemented system for dimensioning virtual paths defined on a telecommunications network carrying general traffic, said network having a plurality of interconnected links whose transmission capacities are limited, said dimensioning method comprising:

means for choosing an appropriate entropy rate function to model the load on each virtual path of said telecommunications network;

means for selecting a solution algorithm using the entropy rate function as a blocking measure that is operative to solve a load balancing problem for said general traffic; and

means for performing computations on a computing system using said load balancing algorithm incorporating said entropy rate function to produce a load distribution on said virtual paths that is as uniform as possible and wherein said algorithm using the entropy rate function as a blocking measure that is operative to solve a load balancing problem for said general traffic is a push down algorithm

means for grouping all virtual paths into a dimensioning set;

means for specifying the transmission capacity of each physical link;

means for choosing a relatively large initial blocking value for each virtual path;

means for selecting an error bound to evaluate the convergence of a critical link identifying algorithm;

means for determining the blocking value for each virtual path using an entropy blocking measure;

means for iteratively identifying the virtual path having the largest blocking value as long as the physical link has available capacity;

means for reducing the blocking of the virtual path having the largest blocking value by reallocating transmission capacities amongst said virtual paths as long as no physical link reaches full utilization and the blocking reductions of the maximally-obstructed virtual path is greater than a preselected error bound;

means for identifying physical links lacking allocable capacity as critical links;

means for eliminating all virtual paths spanning critical links from the dimensioning set; and

means for iteratively readjusting the transmission capacities of the remaining physical links to reflect the capacities allocated to virtual paths most recently eliminated from the dimensioning set; and

wherein the step of reducing the blocking of the virtual path having the largest blocking value in the push down algorithm is performed using a successive approximation technique.